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CONTENTS

GEOLOGY OF THE COLORADO RIVER BASIN WITH REFERENCE TO ENGINEERING PROBLEMS[1]

ANY account of the geology of the Colorado River basin falls naturally into two parts: that which deals with the life of the Colorado River and that which describes the preceding ages before the river began to flow. Professor Pack has presented the life history of the river. It is my task to sketch the earlier history of this part of the continent. With reference to the engineering problems, the geologist is concerned with three questions relating to the stability of the dam as affected by possible earthquakes, the nature of the foundation rocks, and the durability of the rocks used in construction. Reference will be made to these matters after the geology has been described.

We have become familiar with moving pictures, which present a succession of views, each one of which differs so slightly from the preceding that the eye sees their sequence as a continuous movement. The intervals are fractions of a second. The action is timed to our human scale. Geographic changes are exceeding slow. If we would present a moving picture of a succession of landscapes, the intervals between the views would be a hundred thousand or even a million years. Even so, the eye would see a continuous procession of views. Mountains would grow to majestic heights and waste away till their sites became plains. Rivers would develop and competing for territory would become master streams or tributaries according to the law of the strongest. Seas would invade the land and retreat from it after ages of occupation. Climates, floras and faunas would change. Such is the moving picture of geologic

[1] Presented in the Symposium on "The Problems of the Colorado River" at the Salt Lake City meeting of the American Association for the Advancement of Science and the Pacific Division.

history. It is timed to the march of the ages.

Even that slow movement of events is beyond our power to present in its continuity. We can at best represent widely separated conditions. And so, in attempting to sketch the history of the Colorado Plateau region, I can give you detached pictures only, some of them so unlike that imagination alone can link them together. It will be simplest to roll the broken film backward from the later, better known events to the earlier scenes, till knowledge becomes guess and guess fades into surmise in the mists of antiquity.

The Colorado River developed during a period before the present plateaus were elevated. So great a river system, like a great empire, is the result of many territorial conquests. The force by which it conquers is due to its fall, for by its fall it carves its canyons and extends its tributaries. Thus the earlier history of the river corresponded with an earlier ancient uplift of the plateau country. But that uplifted mass was first gashed by canyons, then became a land of broad valleys and mesas, and finally was eroded to a low plain. A later uplift has raised that plain to its present position, 7,000 feet above the sea, where it is the surface of the plateau.

The cycle of erosion just referred to is called the "Great Denudation." The time of its duration corresponded with the so-called early Tertiary. The early mammals drank from the growing Colorado. North America then, as now, stretched from the Atlantic to the Pacific, an undivided continent.

Stepping back a million years or so, we see North America divided. A broad, though shallow, strait stretched from the Gulf of Mexico to the Arctic Ocean along the Great Plains of to-day, dividing the continent into an eastern and a western land. The climate was mild and equable. Vegetation flourished in the warm humid atmosphere. It was the Coal period of Colorado and New Mexico. Great saurians dominated the life of the period, yet became extinct, apparently rapidly. Dull brutes, they were incapable of adaptation to changes of environment such as closed the period of their dynasty.

During this period, the so-called Cretaceous, the region of the Colorado plateaus was a watered land with rivers flowing from eastern coast ranges, on the site of the Rocky Mountains, toward the Pacific. Among them may have been the stream which eventually grew to the Colorado, but we can not identify it.

Still retreating down the aisles of time, we come upon the panorama of a wide North America, united from east to west, but submerged along the western margin even to Idaho. This, the Triassic and Permian periods of geologists, might well be called the period of the "Great American Desert." A red windswept delta plain covered the Rocky Mountain states from Montana to Arizona and extended southeastward over Oklahoma and Texas. Bleak and arid, it was like the plains of northern Siberia. Similar cold, barren lands existed widely throughout the continents. It was a time of stress for all living things and led to the evolution of higher forms than had previously existed when conditions bettered, just as the severe environment of life during the Glacial Period later led to the evolution of man from his ape-like ancestors.

The red muds and sands of the desert time reached far into the Colorado Plateau country and, in so far as they were not eroded during the "Great Denudation," they give the dominant color note to the upper gorges of the river.

Thus far in our retrospect we have found no epoch during which the plateau country was submerged beneath sea waters. Yet there is written in the strata of the canyon walls a very long record of marine conditions. Whoever has been down the Bright Angel Trail has seen it. The cliffs of sandstone shale and limestone demonstrate by their long horizontal lines of bedding, as well as by the fossils they contain, that they were laid down beneath the sea. It was never a deep sea, yet there gathered in the basin more than 4,000 feet of strata. Evidently the bottom sank gradually and the sediments gathered as the basin deepened. Far more impressive evidence of subsidence is found near Salt Lake. There the strata aggregate more than 40,000 feet in thickness and indicate a corresponding subsidence of the ancient foundation rocks.

It is clear from the great difference between 4,000 and 40,000 feet that we should not re-

gard the subsidence as uniform. On the contrary, it was an unequal warping of the surface, which indeed rose and remained land in the region southeast of the canyon, or was but temporarily submerged.

The invasion of the sea into western North America began with and extended through the so-called Paleozoic age, that vast lapse of time during which life evolved from the grasping crustacean to the ambitious reptile. It is one of the proofs of evolution that although the Paleozoic creatures are long since extinct, their mentalities still persist in individual men. According to geologists the Paleozoic was an era which began with the Cambrian period and closed with the Permian. Various intervening periods are distinguished, but for our study of the Colorado River basin, the Paleozoic stands for one event, the advance of ocean waters over much of the continent, their prolonged occupation of its area accompanied by numerous changes of front, and their retreat into the permanent ocean basins.

Back to the beginning of the Paleozoic era, including the Cambrian period, we have fairly complete records of the physical geography of the earth and we can trace the major lines of evolution of organic life. We can even attempt maps of the shifting lands and seas, follow the course of great climatic oscillations, and image in our minds the habitats in which our remoter and nearer ancestors lived. If we draw a parallel between human history and earth history we may compare the dawn of Assyria with the beginning of the Paleozoic. But the remoteness of Assyria is to be measured only in hundreds, whereas that of the early Paleozoic is to be estimated in as many millions of years.

Let us not think, however, that a hundred million years represents a large proportion of the earth's history, as it is recorded in the rocks of the Grand Canyon. Beneath the earliest Paleozoic strata lie other water laid deposits of sediment, the waste of ancient lands. Only a few fragments of those old records are known, but they testify unmistakably to the passage of unnumbered ages.

We are prone to think the earth must have been in a different state of cooling or had a different atmosphere in so distant a past. But no, the winds blew, rains fell, streams flowed, there was night and day, heat and cold. And within the earth there went on periodically those changes which occasion the rise and subsidence of continents, the growth of mountain chains. The Algonkian strata (such is the name geologists use to designate the era) were deeply buried, tilted up, invaded by masses of molten rock and eroded. They record activities identical in kind and intensity with those which are now active in the most youthful ranges, the Rocky Mountains and the Sierra Nevada. Though we look back two hundred million years we find earth-processes the same.

Even so we have not read the earliest chapter recorded in the rocks of the Grand Canyon. Beneath the Algonkian we come upon an older and different group of rocks. It is a group which never occurs anywhere but at the bottom. It is the foundation of the superficial crust. I speak of the so-called Archean, the oldest rocks known, though by no means necessarily the oldest rocks ever formed.

The Archean rocks are not surface rocks, not like the strata of the plateau country. They have risen from depths in the earth's crust where temperatures are high and pressures are enormous. The typical Archean are crystalline. Whatever the previous state of the minerals may have been, they have recrystallized. Some, which are called schists, have recrystallized in a solid state under overwhelming and unequal pressures. They have thus changed form, shortening anad lengthening to fit their Procrustean bed. Others, the granites, have been melted and have intruded as tongues of magma into surrounding masses, causing changes of crystalline form in them. Melting and recrystallizing, crystallizing and remelting, these rocks have undergone changes so complete that no one can tell what they may once have been nor through what sequence of kneading, mechanical shearing, folding, and chemical changes they may have passed.

The Archean rocks thus represent physical and chemical conditions which exist within the earth's outer shell. I say advisedly *exist,* not *existed.* For while it is true that we see only very ancient rocks of this character, there is every reason to assume that they are forming now beneath our feet. We know that the

earth, though solid, is very hot. We know that very great and unequal pressures exist at depths of a few miles beneath the surface. These are the conditions under which the Archean rocks formed and no doubt are forming.

In the laboratory of the Master no reaction occurs except according to law, and law is eternal, unchanging. There is, perhaps, no thought with which we may more appropriately approach the engineering problems of the Colorado River.

The engineers who will speak here of the utilization of the Colorado will describe works of great magnitude: dams surpassing any yet built; reservoirs impounding millions of acre feet of water; values of irrigated lands rising to hundreds of millions of dollars; powers which are to turn the wheels of industry from San Francisco and Los Angeles to Denver. But even so, they speak only as men, of the little works of men. In the laboratory of the Master their greatest accomplishment is infinitely small and transient.

A laboratory is a place where the forces of nature work changes in material compounds or crystal forms according to law. The mechanic, the physicist, the chemist arranges the conditions of some desired reaction and under the same conditions observes the identical effects recurring endlessly, unfailingly. If he makes an experiment the personality of the experimenter makes no difference. Even the Master works by law and can not work otherwise. Nor does time make any difference. A billion years ago the law of gravitation held the stars to their courses as it does to-day. In the earliest conceivable eon of the existence of matter the atoms moved to their places in molecules in the same order as now.

Yet there is a new development, no doubt also in obedience to law, but so subtle that we can not establish the relation. I mean the evolution of mind, which can investigate law, which can conceive and execute great works that rightly constructed will stand for ages. The mind can even trace its own evolution. Backward from human thought to animal instinct, from instinct to mere conscious existence, from consciousness to unconscious molecular reaction runs the chain. It runs unbroken. Life is its characteristic. But if thought is life, then is consciousness also; if consciousness is life, then is molecular reaction also life. In this sense minerals are alive, for they are chemical compounds which react to their environment. The earth is alive, for the reactions of its masses are evidenced in unending change.

The development of thought from unconscious reaction has recently evolved reason. Reason is so young, however, that it is still embryonic and in many humans is in a larval state. Nevertheless, no man becomes a scientist or engineer without having to some degree developed it and therein lies the hope of a successful solution of the extraordinary problems of the utilization of the Colorado.

The major difficulty in damming the Colorado is to establish the dam on a firm foundation. Investigations of the river's bed show that it is filled to depths exceeding a hundred feet with large boulders. The dam, if it be a masonry or concrete structure, must be welded to the solid rock in place. It will tax the resources of the engineer to the utmost to dig so deep through boulders and to place his foundation structure during the few months between floods, which, if unrestrained, will destroy it.

The presence of a boulder bed, of such depth and composed of rocks of such size, was not foreseen. It is due to the power of the floods. At low water the river ripples impotently around the stones. One can hardly conceive that in flood it moves rocks as large as cabins and buoys up a mass of them, rolling them over one another with irresistible force. But the evidence is there. It does. The bottom of the river in flood is a torrent of rolling rocks, of huge size. They roll, they jam, they temporarily resist. The river piles up its waters behind them. The rocks yield and are carried crashing down the channel to come to rest as the victorious waters roll on.

It is one of the most daring conceptions of modern engineering that this awful power may be used to build the dam that shall chain it. How, may best be stated in speaking of the types of dams that are under consideration.

The engineer and geologist are both cognizant of the power of floods. But there are

some facts regarding the structure of rocks which lie more exclusively in the province of geology. The first of these is what is called "jointing" in rocks. Jointing is a mechanical effect. It is produced by pressure in the case of massive rocks, like granite, or by torsion in the case of strata, when they are warped. All the rocks of the plateau region are jointed. In the magnificent architecture of the Grand Canyon, the vertical cliffs are the planes of joints. In the pointed forms which are characteristic of the deepest gorges in the granite, we see the effect of two or more intersecting joint planes. Now joints permit water to penetrate under and around a block of rock. The film of water may be very thin, but to the extent that it surrounds the rock it buoys it up, tends to lift it from its bed by virtue of hydrostatic pressure, and may free it from its firm foundations. Engineers are fully aware of this action. They seek to excavate to foundation rocks which show no open joints, or to seal visible joints by cement. Granite is regarded as one of the firmest foundations. It is liable, however, to blind joints, invisible planes on which there has been no actual parting, but the minerals have been strained and are ready to react to forces of decay. Water, not enough to wet, but just enough to moisten, is the agent that sets those forces to work. The engineer can not discover blind joints. Investigation of the minerals by the microscope, a study which is among the most specialized of geologic training, alone can demonstrate whether or not they are present.

We may think that the invisible is reasonably negligible. But the infinitely small is the infinitely powerful and also the infinitely patient. A film of water penetrating a plane of strained crystals may open the way to the ultimate destruction of man's mightiest work.

Minerals decay. That is not a familiar thought with many, although soil, a product of mineral decay, is familiar to every one. I said that minerals are alive. And it is because they are alive that they decay, decay being simply the reaction to a change of environment. Evidence of these facts is found in the rocks which the engineer must use in building a dam in the Canyon of the Colorado. The granites and schists of the ancient formations crystallized deep within the crust in an environment of very high temperature and great pressure. Elevated to their present positions at the surface they are in a cool environment, under little pressure. The change produced in every crystal a tendency to change, to disintegrate into forms and compounds better suited to their actual environment. Thus the seemingly solid granite of the Boulder Canyon site is pervaded with disintegrating forces, which will in the course of time, though probably long time, certainly cause it to crumble.

Let us now consider the two methods of building the proposed dam, which have been suggested. The first fascinates by its unusual character and its daring. It consists in blowing great masses of rock from the canyon walls into the river channel in such quantity that they will form the body of a dam three quarters of a mile up and down stream on the base and six hundred feet high. The blasting is not to be done all at once, but in sections from upstream downward and only to a part of the height at any one time. And the river is to be allowed to flow over the fallen rock masses in such manner that it will by its own power dig the deep hollows into which it shall also roll the great rocks. Thus the river shall work its will, but shall lay the masses where it can never move them again. It shall chain itself.

The success of this operation depends upon providing by blasting rock masses of such magnitude that the river can not carry them away. We have a report by Mr. Ransome, a geologist of the U. S. Geological Survey and one of the highest rank, to the effect that the granite of Boulder Canyon is considerably jointed. Conservative knowledge would suggest that there are many more joints than appear as actual fissures and that they would cause the granite to break into relatively small masses, in the blasting from the cliffs and subsequent rolling by the river.

Another question is how "solid" is the granite? That it is so described is natural, for "granite" and "solid" are almost synonymous terms to English speaking peoples. The significance of words depends upon our association with them and our experience of New

England granite says that it is the very symbol of solidity. But New England granites have been stripped by glaciers of every trace of decayed rock. They are solid because they are freshly exposed. That is not the case with granites in this western country.

For instance there is granite in the immediate vicinity of Salt Lake City. It seems solid. It is used in building. It will take a polish. But I am told it will not hold a polish more than three or four years, because the crystals have begun to decay. Professor Pack tells me that he has examined granite in this vicinity from the surface to a depth of 800 feet below it and found even at that depth that decomposition was in progress, as shown by the clouded appearance of certain crystals, the feldspars, under the microscope.

The granite of Boulder Canyon is decomposed on the surface. No one knows, as yet, to what depth. But the geologist has reason to suspect its solidity and must add his objection to those of conservative engineers against the suggestion that the dam be built by blowing the cliffs into the canyon.

The other type of dam proposed is to be built of reinforced concrete. Concrete may be described as a rock composed of minerals which are permanent under surface conditions because they form in that environment. Moisture promotes the consolidation of concrete. Age increases its strength. So far as the superstructure is concerned, a geologist must reason that a concrete dam will outlive a rock fill dam. The engineering problem in building a concrete dam is that of excavating to solid foundations. It is, in the judgment of conservative and experienced engineers, reasonably practicable to do so. But, if the conditions of jointing and decay of the rocks are considered as they should be, it will be the geologist rather than the engineer who shall determine whether they are solid or not.

The foundations are now being explored by drilling. It is not enough. A drill may bore out a core within a foot of a weak seam and not betray its existence. The preliminary examination will, no doubt, be followed by more thorough investigation and it may be suggested that a method of shafts and tunnel be employed. Shafts sunk, one on each side of the river, and connected by a tunnel at a depth of a hundred feet below the bottom of the channel, would enable a complete examination of the rock, inch by inch. Weaknesses could be excavated and filled. If they should prove too numerous at one hundred feet, the shafts could go deeper to a deeper tunnel. Eventually when solid rock was found, the rock above the tunnel could be cut away to the surface, stoped, as miners say, and the stope filled with concrete would form an impervious curtain wall. Working from the bottom up, the bed of the river would be approached and the deeper foundations would be laid without exposure to the risk of floods. It is not the province of the geologist to instruct engineers and I would not presume to, but the suggestion may stand to illustrate the problem of a deep and secure foundation, that the geologic conditions demand.

The Garden of Eden was created some five thousand or more years ago by the building of huge dams of earth to control the Tigris and Euphrates, and so well did those ancient engineers execute their task that the beauty of the garden became a tradition of all Eurasian races. The garden endured until the state fell. Subtle forces weakened the quality of its citizens as moisture attacks the minerals of the granite. Our engineers can build a dam to endure for thousands of years. What is the endurance of our state? What concrete foundations of national character are we laying to cut off the underground activities that would destroy it?

BAILEY WILLIS
STANFORD UNIVERSITY

EXPEDITIONS OF THE MUSEUM OF NATURAL HISTORY

IN one of the corridors of the American Museum of Natural History the officials of that institution have hung a map of the world to which labels are attached showing the distribution of its exploring parties and field workers. During the present year a larger number of expeditions have been sent out than ever before. Intensive work is being pursued by each department.

In the department of geology, Dr. Edmund O. Hovey is at present on a trip through Cali-

fornia, Oregon, Washington and British Columbia, securing data and photographs for the purpose of the construction of a number of relief models, showing most interesting geological formation in these states. Associate Curator Reeds is working in the vicinity of New York, collecting data for a museum exhibit to show the "Climates Past and Present," and Mr. Foyles is continuing his studies in northwestern Vermont on the Fort Cassein terrain.

For the department of vertebrate paleontology, an expedition in charge of Albert Thomson is at work in western Nebraska, seeking fossil mammals from the Snake Creek beds of the Pliocene age. Working in the same vicinity is Curator Matthew, who will shortly be joined by Mr. Olsen. Mr. Barnum Brown, who is well known from his success in securing most of the Brontosaurian material now on exhibition in the museum, is at work in the Siwalik Hills of India, obtaining fossil mammals and other invertebrates from a famous fossil bearing formation. In the late autumn, it is the intention of President Henry Fairfield Osborn to join the Third Asiatic Expedition, which has connected with it, in charge of paleontology, Mr. Walter Granger. Working with Mr. Granger at the present time are Professors Charles P. Berkey and Frederick K. Morris. Already extensive shipments have been made by this expedition. Mr. Childs Frick, one of the trustees of the institution, will continue fossil collecting in southern California, where he has already obtained an extensive collection from the Pliocene.

Dr. Frank M. Chapman, curator of the department of birds, accompanied by Mr. George K. Cherrie and Captain O'Connell, are in Ecuador continuing their studies on the distribution of bird life in the Andes. They will first investigate southern and southeastern Ecuador and will then conclude their work by a boat trip from Guayaquil along the coast to Paita, Peru. Assisting in the investigations in bird life in Ecuador, Henry Watkins is now engaged in the mountains of Peru. His latest shipment comes from the humid regions northeast of Lake Junin. Ernest Holt, formerly of the United States Biological Survey, is engaged in collecting birds and mammals for the museum in the mountains of eastern Brazil. A collection was recently received from him which was secured around Mt. Itatiaya. Later Mr. Holt will explore still higher peaks. The museum's representation of bird life from this important region has until now been confined entirely to specimens in the old Prince Maximilian Collection. José G. Correia is undertaking the collection of birds at the Cape Verde Islands, and Rollo H. Beck, who is working under the auspices of the Whitney South Sea Expedition, is collecting in the Society Islands. Mr. Beck is accompanied by Mrs. Beck and Mr. Quayle. Mr. Griscom is doing work in New Foundland, while other members of the department are engaged in the local field.

The department of mammals has G. H. Tate in Ecuador. He will later be joined by an assistant in order that more intensive investigations of the life of mammals in this region may be studied. H. C. Raven, who accompanied Dr. W. K. Gregory to Australia last year, has nearly completed a systematic collection in Queensland and will next go to the great Nullaboa Plain in South Australia. He has already obtained for exhibition and study a series of the marsupial mammals.

In September, Herbert Lang, assistant curator of African mammals, will leave for British Guiana for a three months' trip. At Georgetown he will join William La Varre and will go up the Essequibo River through the diamond mining district along the Mazaruni. He hopes to go through the savannah country and Mt. Koraima. By studies of the conditions in this section at first hand, Mr. Lang has an opportunity to compare the ecological conditions in the great South American forests and savannahs with those of equatorial Africa, a comparison which has long been needed in connection with the preparation of his reports on his Congo expeditions.

Dr. F. E. Lutz, of the department of entomology, is engaged in work in the vicinity of Boulder, Colo. F. E. Watson, of this department, recently returned from a four months' trip to Haiti where he secured approximately eleven thousand specimens of the lower invertebrates, chiefly insects, and about three hun-

dred miscellaneous specimens of fishes and reptiles. He is now carrying on local field work, having in view the collection of material for several butterfly groups.

R. W. Miner, of the department of invertebrate zoology, is continuing field studies in southern New Jersey in connection with the construction of a new rotifer group. Assisting him is Research Associate Frank J. Myers, whose well equipped laboratory at Ventnor, New Jersey, is the basis of operations.

Dr. Russell J. Coles is collecting material for the department of ichthyology off the coast of North Carolina. Mr. Louis L. Mowbrey has sent in some important material for this department from the Florida waters.

Dr. G. K. Noble, of the department of herpetology, accompanied by Mrs. Noble, has left for the Dominican Republic. The chief object of this expedition is to secure data, photographs and material toward the construction of the two habitat groups for the new Hall of Reptiles in the museum. The West Indian region is rich in reptilian and amphibian life. Perhaps the two most striking creatures in this locality are the rhinoceros iguana and the giant tree frog. Both these forms are confined to the island of Santo Domingo. The expedition will travel over a large part of the island in the course of its investigations. The rhinoceros iguana is found to-day chiefly in the arid southwestern portion of the island in the vicinity of a dead sea, the surface of which is more than a hundred feet below sea-level. The giant tree frog has been taken only in the Central Cordillera and on the Quita Espuala, a range of mountains in the northeastern part of the island. It will be necessary for the expedition to carry on its work during the height of the rainy season in order to secure information in regard to the life history of the giant tree frog. Although this species is the largest and most spectacular tree frog in the world, its life history is entirely unknown, and the expedition hopes to secure valuable scientific data as well as exhibition material.

While field work in the department of anthropology is necessarily restricted for the present year, nevertheless, Mr. Nelson, of the Division of Archeology, is in Europe, engaged in a study of the paleolithic and neolithic collections in the museums abroad, and will endeavor to secure specimens to round out the exhibition series in this museum. During his trip Mr. Nelson will visit Norway, Sweden, Spain and Belgium.

Earl H. Morris, who for a number of years has been engaged on the Huntington Expedition work at Aztec, New Mexico, in company with Charles L. Parnheimer, of this city, is now busy making a general reconnaissance of the Navajo mountain region of New Mexico. Dr. P. E. Goddard, of this department, accompanied by Lieutenant G. T. Emmons of Princeton, left early in June for a trip to the Northwest Coast. It is the intention of this party to secure specimens and authentic data which will make possible an early completion of the North Pacific Coast Hall.

PROPOSED FEDERATION OF AMERICAN BIOLOGICAL SOCIETIES

THE second conference called to consider the question of cooperation or federation among biological societies met in Washington in the rooms of the National Research Council, on April 23, 1922. This meeting was held in pursuance of a resolution adopted at an informal conference in Toronto, December 27, 1921, and approved by the societies there in session. The conference organized under the chairmanship of Professor L. R. Jones, who had also presided over the Toronto gathering.

Plans for the 1922 meeting, in so far as they could be arranged by agreement among the officers of the several societies, were entrusted to a committee consisting of the secretaries of the American Society of Naturalists, Botanical Society of America, and American Society of Zoologists, in cooperation with the permanent secretary of the American Association for the Advancement of Science.

The view was generally expressed that the conference should, if it decided to recommend any form of federation, present a definite plan of organization. A committee was accordingly raised to formulate such a plan. This committee, of which Professor F. R. Lillie was chairman, reported to the conference the fol-

lowing recommendations, which were adopted:

1. That the vote of the Toronto conference in favor of the idea of federation be reaffirmed.

2. That the proposed federation be styled the Federation of American Biological Societies.

3. That the members of the federation be societies, not individuals, and that all societies represented in this conference (a list of which is given below) be eligible to charter membership.

4. That a council of the federation be established, consisting of two representatives from each society, these to be the president and secretary unless otherwise designated by the society.

5. That the council choose an executive committee from its own membership.

The committee that made the foregoing report was continued as an executive committee *pro tempore* of the conference, and to it was intrusted the task of drawing up a constitution and by-laws in accordance with the above general plan. The instructions of this committee call for completion of its work at a reasonably early date, and the transmission of its decisions and recommendations to the officers of the several societies by correspondence. It is expected that it will be possible to distribute the proposed constitution and by-laws to the members of the societies early next fall.

The executive committee *pro tem.* has the following personnel: Frank R. Lillie, University of Chicago; C. W. Greene, University of Missouri; I. F. Lewis, University of Virginia; C. E. McClung, University of Pennsylvania; A. Franklin Shull, University of Michigan; R. E. Thatcher, Agricultural Experiment Station, Geneva; H. B. Ward, University of Illinois; and B. E. Livingston, representing the American Association (Herbert Osborn to substitute for latter at August 4 meeting).

Considerable discussion was devoted to the problem of improving biological publications, a question likely to come before the council, if the plan of federation shall be adopted. This problem was considered so important that it was deemed advisable by the conference that some action be taken without waiting for the establishment of the federation. A special committee was, therefore, appointed to work in cooperation with a committee on the same subject from the Division of Biology and Agriculture of the National Research Council, to study the whole question of biological publications and report to the conference or to the federation if formed. The personnel of this committee is as follows:

A. P. Hitchens, Army Medical School.
I. F. Lewis, University of Virginia.
C. A. Kofoid, University of California.
D. R. Hooker, Johns Hopkins University.

The corresponding committee of the Division of Biology and Agriculture of the National Research Council is composed of the following members:

E. D. Ball, Department of Agriculture.
C. E. McClung, University of Pennsylvania.
J. R. Schramm, National Research Council.
A. F. Woods, University of Maryland.

The biological organizations represented at the Washington conference were as follows:

American Association for the Advancement of Science.

Sections F (Zoology), G (Botany), N (Medical Sciences), and O (Agriculture) of the American Association for the Advancement of Science.

Federation of American Societies for Experimental Biology.

The Executive Committee of the Division of Biology and Agriculture of the National Research Council.

American Society of Naturalists.
American Society of Zoologists.
Botanical Society of America.
Genetics Sections of the Botanical Society of America and the American Society of Zoologists.
American Genetic Association.
Ecological Society of America.
American Phytopathological Society.
American Society for Horticultural Science.
Society of American Foresters.
Society of American Bacteriologists.
American Society of Agronomy.
Entomological Society of America.
American Association of Economic Entomologists.
American Society of Animal Production.
American Dairy Science Association.

A. FRANKLIN SHULL,
Secretary of the Conference

HUIA ONSLOW

AT Cambridge, England, on June 27, Mr. Huia Onslow died. He was born in New Zealand on November 13, 1890, where his father, the Earl of Onslow, was then governor-general. To commemorate the place of his birth, he was

given the Maori name Huia, and was regarded as the honorary chief of a Maori tribe. Queen Victoria became his godmother. Favored by circumstance, strong and handsome, he passed through Eton and Cambridge University, with every prospect of a brilliant career. But when taking a holiday in the Tyrol in July, 1911, he struck his head against a rock in diving, and was so severely injured that he became paralyzed from the waist downward. An apparently helpless invalid, he was condemned to spend the rest of his life on a couch, able only to move his head and arms. Many men, so situated, would have given up all idea of useful activities, lamenting a life of supposedly unavoidable idleness. Not so Mr. Onslow. Having been much interested in biological subjects when in college, he returned to Cambridge, secured the necessary assistants, and ardently devoted himself to biological research. Those interested in genetics will remember his papers on heredity in moths, based on breeding experiments carried on in his laboratory. His doubtless most important work, of 74 pages, was "On a periodic structure in many insect scales, and the cause of their iridescent colours" (*Philosophical Transactions of the Royal Society*, July, 1921). In this elaborate and fully illustrated paper the iridescent colors of many insects of various orders are studied, using all the modern refinements of microscopic technique and the latest pertinent researches in physics. All the drawings on the three plates are by Mr. Onslow. A few years ago Mr. Onslow was married to Miss Muriel Wheldale, formerly a fellow of Newnham College, well-known for researches on biochemistry and especially for her book on the anthocyanin pigments of plants. Marriage did not prevent her from continuing her work at the university, and so Onslow lived, as he wished to do, in the atmosphere of the laboratories, closely in touch with whatever was going on, himself an actor in the great scientific drama of the day. When I saw him in 1920 I was struck by the keenness of his mind and the breadth of his interests. His was a remarkable life, fruitful in many ways, and ever worthy to be remembered.

T. D. A. Cockerell

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SCIENTIFIC EVENTS

ILLUMINATING ENGINEERING NOMENCLATURE AND PHOTOMETRIC STANDARDS

The American Engineering Standards Committee announces that the Illuminating Engineering Nomenclature and Photometric Standards of the Illuminating Engineering Society, 1918 edition, have been approved by the American Engineering Standards Committee as "American Standard," with the substitution of six internationally agreed upon definitions for certain ones of the 1918 rules. The definitions which have been reworded are: luminous flux, luminous intensity, illumination, candle, lumen and lux.

The special committee of the American Engineering Standards Committee which examined the proposal submitted by the Illuminating Engineering Society and which recommended approval of the nomenclature and photometric standards included representatives of the U. S. Bureau of Standards, the American Gas Association, the American Physical Society, the International Acetylene Association, the Optical Society of America, the American Institute of Electrical Engineers, the Illuminating Engineering Society and the National Electric Light Association.

The new tests to be substituted for existing text in sections 3, 8, 9, 10, 12 and 13 of the Nomenclature and Standards Rules of the Illuminating Engineering Society of 1918 are as follows:

Section 3: Luminous Flux is the rate of flow of radiant energy evaluated with reference to visual sensation. Although luminous flux must strictly be defined as above, it may be regarded for practical photometric purposes as an entity, since the rate of flow is for such purposes invariable.

Section 8: The Luminous Intensity of a point source in any direction is the flux per unit solid angle emitted by the source in that direction. (The flux from any source of dimensions which are negligibly small by comparison with the distance at which it is observed may be treated as if it were emitted from a point.)

Section 9: Illumination at any point of a surface is the luminous flux density at that point, or, when the illumination is uniform, the flux per unit of intercepting area.

Section 10: The unit of Luminous Intensity is the International Candle, such as has resulted from international agreement between the three national standardizing laboratories[1] of France, Great Britain and the U. S. A. in 1909.

This unit has been conserved since then by means of incandescent electric lamps in the laboratories which continue (or remain) charged with its conservation.

Section 12: The unit of Luminous Flux is the Lumen. It is equal to the flux emitted in a unit solid angle, by a uniform point source of one international candle.

Section 13: The practical unit of illumination is the Lux. It is equal to one Lumen per square meter, or it is the illumination at the surface of a sphere of one meter radius due to a uniform point source of one international candle placed at its center.

As a consequence of certain recognized usages, the illumination can also be expressed by means of the following units:

Using the centimeter as the unit of length the unit of illumination is one lumen per square centimeter, and is called the Phot. Using the foot as the unit of length, the unit of illumination is one lumen per square foot, and is called the Foot-Candle.

FRENCH VITAL STATISTICS FOR 1921[1]

THE secretary (minister) of labor recently published the official vital statistics for France for the year 1921. It is an unfavorable report from every point of view. The number of births is below that of 1920, while the number of deaths has increased; the number of marriages has also decreased. The excess of births over deaths, amounting to 159,790 in 1920, or forty-one for each 10,000 inhabitants, decreased in 1921 to 117,023, or thirty for each 10,000 inhabitants.

A comparison of the number of births and deaths for the years 1921, 1920 and 1913 is shown in the following table:

Year	Total Population	Births	Deaths	Excess of Births
1921	39,209,766	813,396	696,373	117,023
1920	39,209,766	834,411	674,621	159,790
1913	41,476,272	790,355	731,441	58,914

The number of marriages, which reached an unusually high figure in 1920 (623,869), dropped in 1921 to 456,221, but it is still appreciably higher than the number recorded in 1913 (312,036).

An examination of the report brings out the fact that whereas the number of living births for each 10,000 inhabitants in 1920 was 213, it fell in 1921 to 207; in 1913, it was 191. The relative proportion of deaths has risen from 172 for each 10,000 inhabitants in 1920 to 177 in 1921, reaching about the same proportion that was recorded in 1913—176 for each 10,000 inhabitants.

In 1921, sixty-seven of the French departments showed an excess of births over deaths, the total amounting to 127,654, as compared with seventy-three departments in 1920. On the other hand, twenty-three departments showed an excess of deaths over births, the total amounting to 10,631, as against seventeen departments in 1920. The seven departments which, in 1920, showed an excess of births over deaths but in which the balance in 1921 was on the side of the deaths are: Aube, Cher, Côte-d'Or, Maine-et-Loire, Orne, Seine-et-Marne and Seine-et-Oise. In the department of Isère, which in 1920 showed an excess of deaths over births, the excess of births over deaths in 1921 was 292. During the year just preceding the war (1913), an excess of births over deaths amounting to a total of 86,768 for fifty-two departments was recorded, and an excess of deaths over births amounting to 27,854 was found in the thirty-eight other departments.

The departments in which the excess of births over deaths, in 1921, reached the highest figures are: Nord, Seine, Pas-de-Calais, Finistère, Moselle, Bas-Rhin, Seine-Inférieure, Côtes-du-Nord, Morbihan, Haut-Rhin, Aisne, Meurthe-et-Moselle, Ardennes and Bouches-du-Rhône. In all these departments, with the exception of Aisne, Meurthe-et-Moselle and Ardennes, the excess of births in 1921 was much less than in 1920.

The departments in which the excess of deaths over births, in 1921, was highest are: Yonne, Var, Gers, Lot, Lot-et-Garonne, Maine-

[1] These laboratories are the Laboratoire Central d'Electricité, Paris, the National Physical Laboratory, Teddington, and the Bureau of Standards, Washington.

[1] From the *Journal* of the American Medical Association.

et-Loire, Nièvre, Hautes-Pyrénées, Seine-et-Oise, Puy-de-Dôme, Vaucluse, Cher and Allier. In all these departments, with the exception of Puy-de-Dôme and Allier, the excess of deaths in 1921 was greater than in 1920; three of these departments, Maine-et-Loire, Seine-et-Oise and Cher, had shown an excess of births over deaths in 1920.

In 1920 (the figures for 1921 are not as yet available), Germany, exclusive of Wurttemberg and Mecklenburg, showed an excess of births over deaths amounting to 623,367; in 1919, the excess of births was 282,230, and in 1918 there was an excess of deaths over births of 299,885. In England, the excess of births for 1920 was 491,781, and for 1921, 390,355.

PRODUCTION OF DYES IN THE UNITED STATES

The United States Tariff Commission reports that the production of dyes in this country declined last year far below that of the previous year, ascribing as the reasons the loss of much of the country's export trade, the general business depression, and the carrying over of large stocks from the previous year.

The commission states that the progress made during the year includes the production in the United States for the first time of a number of dyes of greater complexity and more specialized application. Many of these dyes, which are of secondary importance from the point of view of quantity consumed, are essential in the dyeing and printing of numerous fabrics. These additions to our list of dyes represent an added step toward a well-rounded coal tar chemical industry. The development of many of these new products is a highly technical achievement.

There were 201 firms engaged in the manufacture of coal tar derivatives in 1921. The output of dyes by seventy-four firms exceeded 39,000,000 pounds, a decrease of 56 per cent. from that of 1920. The sales in 1921 exceeded 47,000,000 pounds, valued at more than $39,000,000, and exceeded production by 22 per cent., indicating that a part of the domestic consumption for that year was supplied from the large stocks carried over from the previous year's abnormally high production. The sales of dyes for 1921 exceeded the imports of 1914, when the United States imported nearly 46,000,000 pounds and produced over 6,000,000 pounds of dyes from German imported intermediates.

The average price of all dyes in 1921 was 83 cents per pound, compared with a value of $1.08 per pound in 1920 and a value of $1.26 for 1917. The total quantity of dyes imported in 1921 was 3,914,036 pounds, valued at $5,155,779, or $1.32 per pound, compared with 3,402,582 pounds, valued at $5,763,437 in the previous year. The imports of 1921 represent 10 per cent. of the production and about 8 per cent. of the total dye sales during the year. Germany supplied about 48 per cent. of the total dyes imported during 1921; Switzerland, 41 per cent.; England, 7 per cent., and all other countries, 4 per cent.

Exports of domestic dyes for 1921 show a decrease of nearly 79 per cent., compared with those for the previous year. The value of our exports for 1921 was $6,270,139, compared with $29,823,591 in 1920. The total exports of dyes for 1921 were less than for the year 1917, when the first considerable expansion of the domestic dye industry from pre-war conditions occurred.

The total production of synthetic organic chemicals other than those derived from coal tar, which are used as medicinals, perfumes, flavoring ingredients, solvents and in numerous industrial processes, was 21,545,186 pounds; the sales amounted to 16,761,096 pounds, valued at $13,746,235. The development of this industry in the United States has been similar to that of the dye industry, as our supply of synthetic organic chemicals was controlled primarily by Germany prior to the war.

FELLOWSHIPS FOR MEDICAL RESEARCH

It is stated in *Nature* that Junior Beit Memorial Fellowships of the annual value of £350, and tenable for three years, have been awarded by the trustees to the following, the subject and place of research being given after each: Mr. E. B. Verney: The physiology and pathology of urinary secretion, at the Institute of Physiology, University College, London; Professor F. Cook: A study of the neuro-muscular

apparatus of the uterus, at Guy's Hospital; Dr. J. L. Rosedale: The chemistry of normal and pathological tissue with special reference to the protein and nuclein constituents, at St. Thomas's Hospital Medical School, London; Mr. R. Hilton: The study of the blood gases in various stages of pulmonary collapse produced by artificial pneumonthorax; the condition of the circulation in the collapsed lung, at the Lænnec Hospital, Paris, and at St. Bartholomew's Hospital; Mr. A. St. G. J. M'C. Huggett: The investigation of the function of the placenta in relation to the passage of gases and other substances from the mother to the fœtus and the cause of fœtal apnœa, at the Sherrington School of Physiology, St. Thomas's Hospital, and at the Brown Animal Institution at Vauxhall; and Mr. V. D. Allison: The investigation of the nature and properties of a hitherto undescribed substance which has a strong bactericidal, bacteriolytic and bacterio-inhibitory action—named lysozyme, at the Institute of Pathology and Research, St. Mary's Hospital. Fourth year fellowships of the annual value of £400 have been awarded to Dr. D. Keilin: The life-histories of protozoa pathogenic to insects; the life-history, anatomy and physiology of insects, at the Monteno Institute for Research in Parasitology, Cambridge; and Mr. I. de B. Daly: Auriculo-ventricular block, at the Institute of Physiology, University College, London. The trustees of the Beit Scientific Research Fellowships have re-elected Mr. H. L. Riley and Mr. W. A. P. Challenor to fellowships for the year commencing September, 1922, and elected Mr. H. W. Buston to a fellowship for the same period. All the fellows are required to carry out their research at the Imperial College of Science and Technology. Mr. Riley will continue his research on "The Atomic Weight of Silver, and the Dielectric Constants of Dry Gases" in the chemistry department, and Mr. Challenor will continue his work on "Ring Formation in the Aromatic and Aliphatic Series of Organic Chemistry" in the chemistry department, both under the direction of Professor H. B. Baker. Mr. Buston will carry out investigations on "Nitrogenous Metabolism in Plants" in the biochemistry department under the supervision of Professor J. B. Farmer.

THE SECOND NATIONAL HIGHWAY CONFERENCE

Plans for a second national conference for the study of highway engineering and highway transport education are being prepared by the Highway Education Board, of which Dr. John J. Tigert, U. S. commissioner of education, is chairman. Teachers of highway engineering and highway transport, officials in charge of highway construction programs, members of the automotive industry and kindred fields, together with representatives from other countries, are being invited to attend. The conference will be held in Washington from October 26 to 28 inclusive, and, according to the tentative program, this period will be devoted to the intensive study of highway and engineering problems.

According to a statement of the program committee, the object of the conference is "To review the field of highway engineering and highway transport education in the light of expanding state and federal highway programs and the rapidly increasing social and commercial use of the highways; to discuss general and special courses in undergraduate and graduate curricula; and to exchange views on educational trends arising from these developments in the national transportation system."

Members of the program committee charged with the duty of arranging an adequate program are: Professor T. R. Agg, professor of highway engineering, Iowa State College; Professor Arthur H. Blanchard, professor of civil engineering, University of Michigan; Professor C. J. Tilden, professor of engineering mechanics, Yale University; Professor Lewis W. McIntyre, professor of civil engineering, University of Pittsburgh; H. G. Shirley, chairman of the Virginia State Highway Commission, Richmond, and Dr. Walton C. John, U. S. Bureau of Education, Washington, D. C., chairman.

Seven principal committees will function as the chief activities of the conference, but a program of unusual and exceptional merit, it is said, is being arranged. Tentatively the com-

mittees will be assigned to the study of the following problems: (1) Undergraduate and elective courses in highway engineering; (2) Undergraduate and elective courses in highway transport; (3) Graduate work in highway engineering and highway transport; (4) Short courses in highway engineering and highway transport; (5) Introductory general course in highway engineering and highway transport; (6) Vocational training for non-professional highway personnel, and, (7) Highway traffic regulation and safety.

Information with regard to the conference may be obtained from the Highway Education Board, Willard Building, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

At the meeting of the British Association, which begins at Hull on September 6, for the first time, special lectures are being arranged for children in the secondary schools. These will be given by Professor H. H. Turner, on "The telescope and what it tells us"; Professor J. Arthur Thomson, on "Creatures of the sea"; and Mr. F. Debenham, on "The Antarctic."

The ninetieth annual meeting of the British Medical Association was held in Glasgow, Scotland, from July 25 to 28, under the presidency of Dr. David Drummond, of Newcastle-on-Tyne. Sir William Macewen, Glasgow, was elected president for the year 1922-1923. Mr. Charles P. Childe, Southsea, is president-elect for the annual meeting to be held in Portsmouth in 1923.

Sir William Pope has been elected president of the International Union of Pure and Applied Chemistry for the ensuing three years. The next meeting of the union will be held at Cambridge in June, 1923.

The physicists, Professor H. K. Onnes, of Leyden, Professor P. Zeeman, of Amsterdam, and Dr. N. Bohr, of Copenhagen, have been elected corresponding members of the Berlin Academy of Sciences.

H. Le Chatelier, professor of chemistry at the Sorbonne, Paris, has been presented with a gold medal on the completion of his fifty years of teaching and of service to France.

Colonel Arthur S. Dwight, president of the American Institute of Mining and Metallurgical Engineers, and Charles F. Rand, chairman of the Engineering Foundation, have been made Chevaliers of the Legion of Honor.

The honorary degrees conferred by the University of Edinburgh on July 21 included the doctorate of laws on M. Roger, dean of the faculty of medicine in the University of Paris; Sir Charles Scott Sherrington, professor of physiology in the University of Oxford; Mr. John Bretland Farmer, professor of botany at the Imperial College of Science and Technology, London, and William Somerville, professor of rural economy at Oxford.

Dr. Virgil Snyder, professor of mathematics at Cornell University, received, at the seven hundredth anniversary celebration of the University of Padua, the honorary degree of doctor of the University of Padua.

The Rio de Janeiro Academy of Medicine has conferred the Sampaio prize this year on the pharmacist, P. Seabra, for his work on an electric process for producing nitric acid.

Dr. Gerald L. Wendt resigned on July 1 as associate professor of chemistry at the University of Chicago to join the staff of the Standard Oil Company of Indiana in the direction of research.

The Cross of the Legion of Honor has been awarded to Dr. A. E. Kennelly, professor of electrical engineering at Harvard University and the Massachusetts Institute of Technology, for distinguished services as exchange professor in engineering to the French Republic. Dr. Kennelly will be succeeded as American exchange professor by Dean John Frazer of the University of Pennsylvania, now in France. The French representative to the American institutions, Professor J. Cavalier, director of the University of Toulouse, has returned to France and will be succeeded by Dr. M. E. de Margerie, director of the Geological Service of France.

Dr. Frederick Robert Zeit, for more than twenty years professor of pathology at Northwestern University Medical School, at his request has been relieved of active duty in the medical school. He plans to spend next year

abroad. The pathological museum of the university will hereafter be known as the Frederick Robert Zeit Museum of Pathology.

JAMES B. POLLOCK, associate professor of botany in the University of Michigan, goes to the University of Hawaii at Honolulu for the college year 1922-1923, in exchange with Professor H. F. Bergman.

PROFESSOR HERBERT E. GREGORY and Dr. Levi F. Noble are devoting the months of August and September to geological investigations in southern Utah. At the beginning of the academic year Professor Gregory will resume his work at Yale University.

THE sixth session of a series of graduate medical lectures given at the University of Washington, Seattle, opened on July 17. Five lectures each were given by Dr. Hobart Amory Hare, professor of therapeutics, Jefferson Medical College, Philadelphia; Dr. John B. Deaver, professor of surgery, University of Pennsylvania, and Dr. Williams McKim Marriott, professor of pediatrics, Washington University, St. Louis. Single lectures were given by Dr. William Englebach, professor of medicine, St. Louis University School of Medicine; Dr. Joseph Colt Bloodgood, professor of surgery, Johns Hopkins University, Baltimore, and Dr. Walter B. Cannon, professor of physiology, Harvard University, Boston.

DR. GEORGE MILBRY GOULD, known for his work in medical ophthalmology and especially in eyestrain, formerly editor of *American Medicine, Biographic Clinics* and the Gould Medical Dictionary, died on August 8, aged seventy-four years.

THE death is announced of Professor W. Hallwachs, of the Dresden Technical School, known for his researches on electricity, particularly on the photo-electric effect, and of Professor Otto Lehmann, of the Karlsruhe Technical school, best known for his work on liquid crystals.

THE death is announced from Paris, at the age of forty-one, of Professor Pierre Boutroux, of the Collège de France, formerly professor of mathematics at Princeton University. The son of the philosopher Émile Boutroux and the nephew of Henri Poincaré, himself a mathematician of no little merit, his main work was along the lines of multiform functions and of singularities of differential equations.

Nature says: "Mr. H. G. Wells has accepted the invitation of the labor party of the University of London to offer himself as the candidate of the party at the election for a representative of the university in the House of Commons to be held after the retirement of Sir Philip Magnus at the end of the present session of Parliament. Mr. Wells occupies such a distinguished position in the world of literature and among leaders of thought to-day that his early work in science and education is often overlooked. He was a student at the Royal College of Science, South Kensington, in 1884-87, and was the first president of the Old Students' Association of the College. He took his B.Sc. degree with honors in zoology in 1890, and his first book was a "Text-book of Zoology," written particularly for London University students while he was a teacher of the subject. He is a fellow of the College of Preceptors, and for a short time edited the *Educational Times.* Throughout his career he has been a steadfast supporter of scientific methods in schools and government, and in his books has pleaded the cause of scientific education and research with eloquence and conviction. It is not too much to say that no graduate of the University of London possesses such a rare combination of brilliant literary power and scientific thought or has used these gifts with greater effect than has Mr. Wells in his many and various works."

THE Congress of Learned Societies will meet at the Sorbonne, Paris, from April 3 to 7, 1923.

THE exhibition which opens in Rio Janeiro on September 7 will include displays representing the New England offshore fisheries, the salmon industry, the sardine industry of Maine and California, the oyster industry, the fresh-water mussel fishery, the fish-canning industry, the by-products of the fisheries, and the bureau's relations with the industries. Because of limited allotments of space and funds the exhibit will of necessity be small. A report on the fisheries of the United States, the organization and functions of the bureau, educational opportunities afforded students of

fisheries in the United States, etc., has been prepared for publication in English, Spanish, and Portuguese.

UNDER the presidency of Lord Ancaster, British deputy minister of fisheries, the Deep Sea Fishing Exhibition was held at the Royal Agricultural Hall, Islington, from July 24 to August 5. Among the exhibits were fish from the Dogger Bank shown alive in tanks of salt water, free fish snacks cooked on the premises, the dressing and curing of fish, wireless broadcasting, Scottish fisher girls at work, a diver operating under water, samples of fish not known on the markets, fish luncheons and dinners, a museum with models of various types of vessels, working exhibits, a picture gallery, and films dealing with deep-sea fishing, life under the surface, whaling and pearl fishing.

THE London Natural History Museum Staff Association held their summer scientific reunion in the board room of the museum on July 5. According to the report in *Nature*, among the exhibits were the following: specimen of the supposed gigantic gastropod (*Dinocochlea ingens*) from the freshwater sandstones in the Wadhurst Clay, Hastings; the natural cast of a footprint of an iguanodon from the Wealden Beds. between Bexhill and St. Leonards; opalised mollusca of Cretaceous age from New South Wales and South Australia; skin with scutes of astegosaurian dinosaur from the Upper Cretaceous, Alberta, Canada; specimens from the collection of Swiss minerals bequeathed to the museum by the late Reverend J. M. Gordon; one of the four meteoric stones which fell in the Strathmore district of Perthshire and Forfarshire on December 3, 1917; living specimens of a branchiopod crustacean (*Leptesheria dahalacensis*) hatched from eggs contained in dried mud from Bagdad; ammonites with the operculum preserved and associated fossils from the same bed in the Lias at Charmouth, Dorset; horse chestnut seedlings, illustrating three different methods of replacing the bud of the primary shoot; a very rare British orchid (*Orchis hircina*) recently found near Lewes; examples of the remarkably different, smooth and partly rough, skinned fruits borne on the same tree of the Khatta orange, North India; model of Commerson's dolphin (*Cephalorhynchus Commersoni*) from Port Stanley, Falkland Islands; and the model, enlarged 740 diameters, of the itch mite (*Sarcoptes Scabiei*) recently made for the museum by Miss Grace Edwards. Messrs. R. and J. Beck exhibited their most recent forms of microscope, and Duroglass Ltd. showed examples of their glass-ware for preserving specimens in spirit and for use in chemical analysis.

THE third International Congress of the History of Medicine was opened on July 17, at the Royal Society of Medicine, London. Dr. Charles Singer, lecturer on the history of medicine, London University, presided. The following countries were represented: Belgium, Czecho-Slovakia, Denmark, Egypt, France, Greece, Holland, Italy, Portugal, Rumania, Spain, Switzerland and the United States. Lord Onslow, parliamentary secretary to the Ministry of Health, welcomed the delegates on behalf of the government, after which Dr. Singer addressed the congress. Dr. Laignel-Lavastine acknowledged the welcome on behalf of the foreign delegates. Sir D'Arcy Power, in the absence of Sir Norman Moore, president of honor, said it was a matter of especial gratification that England had been chosen for the third congress. Dr. Tricot-Royer, first president, thought that greater success would result from that conference than from its predecessors. He announced that the next conference would be held at Brussels. At the afternoon meeting of the congress, held at the Royal College of Physicians, Pall Mall, the president of the institution, Sir Humphrey Rolleston, gave an address of welcome, and Dr. Arnold Chaplin, Harveian librarian, described the treasures of the library. The president of the congress and Mrs. Singer gave a reception and conversazione in the evening at the Royal Society of Medicine, when a demonstration on human paleolithic skulls was given by Professor Elliot Smith.

WE learn from *Nature* that a summer course in the Austrian Tyrol has been organized by the directors of Leplay House, London. The course is of the nature of a civic and rustic

survey, and for this purpose the party is divided into groups each of which takes one particular aspect of the work. Mr. H. J. E. Peake, president-elect of the Anthropological Section of the British Association, has undertaken to direct the group studying the anthropological aspects; Dr. M. Hardy will organize a survey of plant life and agriculture, while other sections will deal with the geology, physiography, history and sociology of the district. Group meetings and gatherings of the whole party will frequently be held for the purpose of discussing and comparing results. The tour commenced on August 4 and will last four weeks, although it is possible to arrange for a shorter course of two weeks.

The *Experiment Station Record* states that the Palestine Zionist executive is opening an institute of agricultural research in Jerusalem. This institute will be in charge of O. Warburg as head and botanist, with I. Wilkansky as director of experimental stations and farm management, F. Bodenheimer in charge of entomology, A. Treidal and M. Winik of chemistry, M. Wilkansky of agronomy, L. Pinner of plant breeding, N. Reichert of plant pathology, E. Pickholz of animal nutrition, and S. Zemach in charge of agricultural publications. Departments of horticulture, animal husbandry, irrigation, and agricultural education will be opened next year. The institute will for the present be under the direction of the Colonization Department of the Palestine Zionist Executive, but is expected to be transferred eventually to the Research Institute of the Jerusalem University. Experimental stations in Ben-Shemen for the Shephela, Merhavia for the Jezreel Valley, and Degania for the Jordan Valley were established during the past year. It is anticipated that a similar station will shortly be opened in Beer-Sheba for the Nogob.

According to the *Journal* of the American Medical Association the International Health Board of the Rockefeller Foundation has entered into a cooperative arrangement with the Health Organization of the League of Nations whereby the board will provide a sum not to exceed $32,840 a year, for a period of five years, for the purpose of maintaining an international epidemiologic intelligence service. The board will also provide a sum not to exceed $60,080 a year for three years to put into effect a scheme for the international exchange of public health personnel, to be conducted under the auspices of the health organization of the league. Since the establishment, in 1921, of the intelligence service of the health organization of the League of Nations, it has conducted an international epidemiologic information service, keeping all governments informed as to the status of epidemics of typhus, intermittent fever and cholera, which have been sweeping westward from the famine regions of Russia. It has also undertaken to promote the international standardization of vaccines and serums. It advises the league in matters affecting health and cooperates with the International Labor Organization in promoting industrial hygiene and sanitary conventions for the control of epidemics. It is expected that, by the end of the five-year period, for which funds have been provided by the International Health Board, the epidemiologic intelligence service will have become so efficient and valuable that the various national governments will regard it as indispensable and provide funds for its further maintenance. Interchange of health officials will be arranged, not only for observation but for definite periods of service, which will result in actual exchange of experience. This system of exchanges will be put into effect first in Europe and may be extended to other countries throughout the world.

The Weather Bureau is conducting a study of the constants of anemometers in general use in this country. With the cooperation of the Bureau of Standards about thirty instruments of various dimensions, proportions and weights have been tested in the wind-tunnels of the latter bureau at velocities ranging from five to sixty meters per second. Since the behavior of these anemometers may be different in the variable natural wind, certain instruments tested in the wind-tunnels have been taken to Mount Washington, New Hampshire, for comparison in the very high winds prevailing there. These free-air comparisons will be completed during August, 1922. Following an analysis of the data an improved standard anemometer, recording true velocities, will be

developed and corrections determined for records of velocity already accumulated. Experimental values of the factors or constants of anemometers, throughout the range of velocities occurring in nature, are now available for the first time, and much information useful in the design and construction of these instruments has been obtained. In advance of publication of final results it may be stated that the velocities recorded by the standard Robinson anemometer now in use are about 22 per cent. too high and that the rate of the instrument is more nearly constant than that determined by means of tests on whirling-machines. The three-cup pattern suggested by Dr. Patterson, of the Canadian Meteorological Office, appears to be more satisfactory than the four-cup pattern in general use. This investigation is being conducted by Messrs. S. P. Fergusson and R. N. Covert, of the Instrument Division.

IT is stated in *Nature* that a biological expedition has left Antwerp for Brazil. It is under the direction of Professor C. Massart, of the department of botany in the University of Brussels, and there are four other members of the expedition, two of whom are students. For several years before the war the universities of Belgium and Holland organized expeditions to enable students to go into the field under the guidance of their professors, and it is one of these expeditions, to Brazil, which has now been promoted by the University of Brussels. The party will not aim at exploring Brazil; the object is rather to put the young naturalists directly in touch with tropical nature; they will have the opportunity of collecting botanical and zoological material for study and demonstration and of making ethnological observations. Brazil has been chosen on account of its salubrity and also because, some twenty days' journey from the starting-place, the party will be in the virgin forest. The expedition will remain in Brazil from August until January or February next, and visits will be paid to the state of Rio de Janeiro and Bahia, to the Campos de Minas Geraës, a region in the state of Bahia which is almost deserted, and to some of the peaks of the Sierra de Mantiqueira.

THE *Eugenical News* states that, under date of June 4, 1922, Dr. A. Govaerts, secretary of the Société Belge d'Eugénique, who spent eight months, from September, 1921, to May, 1922, studying the organization of eugenics in the United States, writes that efforts to establish a governmental eugenics office in Belgium have been successful. The new office will be located in the Institute Solvay in Brussels and will be supported by the government. It has been decided to provide regular courses of lectures in eugenics in the State School of Social Service. This school is an organization which prepares its students to undertake actual social service in connection with societies and institutions devoted to charity, the protection of children, and other welfare activities. Professionally, the students of this school will, in the future, be trained, not only as visiting nurses and social workers, but also as eugenical field workers. Dr. Govaerts will organize and give the courses of lectures in eugenics. In general, the courses will be modeled after the instruction provided for the annual training corps of the Eugenics Record Office. Closest contact will be maintained between the Belgian and the American organizations. In Dr. Govaerts' first course of weekly lectures, the following subjects will be treated: Meaning of eugenics; laws of heredity in plants, animals and man; selective matings; the relation between natality and mortality and the national welfare; the technique of eugenics; the field workers' interviews and questionnaires; charting family pedigrees; tracing the descent and recombination of human traits in actual pedigrees; mental and physical measurements in man.

UNIVERSITY AND EDUCATIONAL NOTES

PRINCETON UNIVERSITY has established a library of industrial relations, the expense of which, $12,000 a year, will be defrayed for the first five years by a gift from Mr. John D. Rockefeller, Jr.

MISSION and educational bodies of East China have set in motion a project to build in Shanghai a union medical school at a cost of $500,000. St. John's University of Shanghai,

which now has a medical department, is one of the institutions supporting the project.

WE learn from the *Journal* of the American Medical Association that two chairs in the University of Cincinnati College of Medicine, honoring John D. Rockefeller and Andrew Carnegie, donors of munificent sums to the medical school, were founded at a meeting of the board of directors on July 19. The professorship in obstetrics will be known as the John D. Rockefeller Chair of Obstetrics and the professorship in biochemistry as the Andrew Carnegie Chair of Biochemistry. Dr. William Gillespie holds the chair of obstetrics, and Albert Prescott Mathews, Ph.D., is professor of biochemistry.

DR. STEPHEN RUSHMORE, associate professor of gynecology, has been appointed dean of the Tufts Medical School. The deanship has been vacant since the resignation of Dr. Charles F. Painter, one year ago. Dr. Rushmore is a graduate and former instructor of the Johns Hopkins Medical School.

DR. WILLIAM MOULTON MARSTON has been appointed professor of experimental psychology in the American University at Washington, D. C.

DR. R. W. SHUFELDT, of Washington, has accepted the position of lecturer on art anatomy and zoology on the faculty of the Research University of that city. He will also give a course of lectures at the Catholic University of America on "The Essentials of Natural Science."

DR. H. F. PIERCE, who has been for three and a half years in the department of pathology at the University of Oxford, engaged in research for the British Medical Research Council, has been appointed associate in physiology at the College of Physicians and Surgeons, Columbia University.

M. PRUVOST has been appointed to the chair of geology and mineralogy newly established at the University of Lille.

M. Hesse has been appointed professor of zoology at the University of Dijon.

IN the University of London, Dr. J. C. Drummond has been appointed to the university chair of biochemistry tenable at University College, and Professor Adrian Stokes to the Sir William Dunn chair of pathology tenable at Guy's Hospital Medical School.

DISCUSSION AND CORRESPONDENCE

PASTEUR ON SCIENCE AND THE APPLICATIONS OF SCIENCE

IN his address as president of the American Association for the Advancement of Science, SCIENCE, 54: 650, 1921, Dr. L. O. Howard makes the following quotation from the address of Edwin Linton at the Baird Memorial meeting in Washington in 1916:

> As I look over the titles of theses for doctorate degrees in biology, however, knowing that they must, in some fashion, reflect the activities of our biological leaders, I am led to wonder if the failure of science to influence legislation in the interests of the people is not to be charged to the propensity on the part of these leaders to shun the practical. Is there a hierarchy in science that frowns upon independence of thought and action in her sanctuary? That can hardly be. Let the heads of departments of biological research in our universities then take heart, and not be afraid to follow the lead of Pasteur, who surely committed no violence upon science by undertaking the solution of practical problems.

This reminds me that, about fifty-one years ago, Pasteur had some pretty definite things to say about this matter. In the preface to the fourth edition of "Fragments of Science," December, 1871, Tyndall says:

> My friend M. Pasteur, of the Institute of France, sent me some time ago, among other important books and papers, a short essay entitled "Quelques Réflexions sur la Science en France." It consists of three articles, the first published in January, 1868; the second unpublished, though laid before the Emperor Napoleon at the Tuileries in March, 1868; and the third communicated to a public journal last March. All three articles are conceived in the same spirit, and directed to the same end. The last of them, entitled "Pourquoi le France n'a pas trouvé d'hommes supérieurs au moment du peril," contains many remarks which may wisely be laid to heart in England. In our eager pursuit of "practical" results, the high

preparatory studies contended for by M. Pasteur as essential are only too likely to be underrated or overlooked.

The bearing of his views on the question of technical education, now so much spoken of in England, will be apparent to every reader of the following translation of a portion of the article referred to. Its introduction in this place would be incongruous were it not that the main object of the various essays published in this book was to create a public interest in science as a source of knowledge, and as a means of culture, without present regard to its material results. But the issues of studies animated by this spirit are incalculable; for, though undertaken with no practical intent, they are really the prime movers of all practice. If the purely scientific discoverer die out, practical applications cannot long survive him.

The following three quotations are selected from Pasteur's article:

Few persons comprehend the real origin of the marvels of industry and the wealth of nations. I need no other proof of this than the employment more and more frequent in lectures and speeches, in official language, and in writings of all sorts, of the erroneous expression *applied science*. The abandonment of scientific careers by men capable of pursuing them with distinction was recently complained of in presence of a minister of the greatest talent. This statesman endeavored to show that we ought not to be surprised at this result, *because in our day the reign of theoretic science yielded place to that of applied science.* Nothing could be more erroneous than this opinion; nothing, I venture to say, more dangerous even to practical life, than the consequences which might flow from these words. They have rested in my memory as a proof of the imperious necessity of reform in our superior education. No, a thousand times no! There exists no category of sciences to which the name of applied science could be given. *We have science and the applications of science,* which are united to each other as the fruit and the tree on which it grew.

At one time the majority of the foremost disciples of the École Polytechnique followed the career of mathematical and physical science, and of the higher studies generally. In our day this fact is only a rare exception. It is not that the pupils of this great school are less numerous than formerly, or less capable than their predecessors, the Maluses, the Poissons, the Fresnels, to render their country illustrious by fruitful discoveries, but the course of events invites them to carry the fruit of their studies into the operations of industry, such as the working of mines, the construction of railways, etc.

The German nation has understood that there exists no applied science, but only the applications of science, and that these latter are only rendered valuable by the discoveries which nourish them; while the constant preoccupation of our statesmen regarding public instruction during fifty years has had principally for object primary and secondary education. They have forsaken the higher studies, particularly that of science, to the impulse they had received from the renovation of science in the eighteenth century.

Finally Tyndall says:

The opinions of so eminent a man regarding the relation of science to its applications, and to the general culture of the nation, merits our gravest attention.

Charles Robertson

Carlinville, Illinois

CULTIVATION AND EVAPORATION

To the Editor of Science: Dr. L. S. Frierson (in Science, March 24, 1922, p. 317) shows by his remarks the danger of confounding facts with their explanation. What "all practical farmers from the days of King Hamurabi to date" agree upon is the *fact* that cultivation helps plants in dry weather. But Dr. Frierson and I have differed as to the *explanation* of this fact—he believes that cultivation "stops evaporation, and thus conserves the store of soil water," whereas my view was that "a greater total surface is exposed to evaporation, and evaporation is therefore facilitated."

The remarks of Dr. H. A. Noyes (in Science, June 9, 1922, p. 610) throw further light on the subject. He believes that "cultivation lets air down in the soil, thereby increasing bac-

terial activities which in turn cause the plants to get more food and grow larger on less moisture." In the *Journal of Industrial and Engineering Chemistry* for March, 1922, Dr. Noyes reported experiments where "fertilization has decreased the water requirements of plants over one half, when expressed as the amount of water necessary to produce one unit weight of plant." "It appears that if the soil solution is weak, the plant transpires more water in its attempt to make a normal growth."

The observations of Dr. Noyes seem to confirm my application of Bechhold's "capillary phenomenon" in agriculture (Science, July 22, 1921), because increased evaporation at the surface of the ground in the immediate neighborhood of the plant would mean a richer soil solution within reach of the plant roots; so that even if some water is lost, the plant can get its food requirements with less water. The uncultivated soil near the plant may even be robbed of its food and moisture by sidewise diffusion streams. As W. Kraus showed, the movement of salts in the Bechhold "phenomenon" is dependent upon evaporation at the exposed surfaces (*Kolloid Zeitschrift*, 28, 161, 1921).

Another important factor is the *rate* at which the soil water reaches the plant roots. This must at least equal the speed at which moisture is evaporated by the leaf system, otherwise the *wilting coefficient* is reached and the plant droops. In this connection Sir E. J. Russell, director of the Rothamsted Experimental Station, pointed out that the availability of nutrients should properly be measured by the *rate* at which they reach the roots which absorb them. (*J. Agri. Sci.*, 1, 327).

According to the Bechhold phenomenon, cultivation of the soil immediately above the roots (which is where cultivation takes place) increases evaporation there and the accelerated *upward* and *sidewise* diffusion streams carry the essential water and food with sufficient rapidity to favor plant growth. Russell says (*Trans. Faraday Soc.*, February, 1922) that a crop of wheat weighing with its straw about four tons per acre, transpires during its lifetime about 1,000 tons of water per acre, the actual strength of the soil solution varying from 0.0001 to 0.006 per cent. according to treatment.

Dry weather usually comes when the plant's leaves are well developed; and in any event it means a period of rapid evaporation from the leaves. Especially *then* has cultivation been found a life saver, and often an actual aid to growth.

The remarks of Dr. Cyril Hopkins (quoted by Dr. Frierson to support his view) that the soil is "stirred after each rain to prevent evaporation, and thus store up sufficient moisture in the soil to give the crop a good start," do not militate against my view; for Dr. Noyes' experiments show that cultivation, by allowing the plant to grow with less moisture early in the season, enables it to enter the drought period "with an accumulative reserve of soil moisture." This is a most important conclusion. It seems to me, however, that the Bechhold phenomenon of salt concentration or movement also explains why a plant may thrive on less water; for this lesser amount of water, enriched by diffusion, has the essential plant foods.

Jerome Alexander

Ridgefield, Conn.

REPOSITORIES FOR SCIENTIFIC PUBLICATIONS

To the Editor of Science: Recent discussion in Science as well as in other places is indicative of the increasing interest in efforts to extend limited funds so as to cover rapidly expanding scientific writings or to curtail such writings so as to bring them within the limits of the funds.

This interest is considerably augmented by the realization of workers in certain lines that there is also a problem of storage space for multitudinous papers and a kindred problem of finding time and energy for reading such as come to hand.

In the course of recent discussions with representatives of the University of California Press and the University of California committee on research I have been impressed with the need for adoption of a general policy with regard to certain features (at least) of scientific publications.

It is my understanding that the University

of California officials are about ready to adopt for their publication material of all departments the settled policy of curtailing or excluding generally explanatory discussion which is plainly redundant or needlessly explicit, and of curtailing or excluding tabular, statistical or other exhibitive matter which is likely to receive little or no attention from most readers. But, in order that such exhibitive material shall not be lost to permanent record (where its value may be far superior to mere textual discussion) it is expected that limited numbers of copies of such matter will be mimeographed or otherwise duplicated and placed in certain repositories designated because of their accessibility to those persons most likely to need such records.

Such a plan seems to offer the best possibilities for meeting the adverse conditions mentioned, but since it is probable that in many or most cases the individuals or organizations concerned will be expected to arrange matter for deposit there is danger of much confusion in the process of accumulation at points of deposit.

Possibly the National Research Council can give early assistance in the matter by obtaining the consent of available institutions to act as repositories and also by classifying them according to local interests if that should seem desirable. For example, an institution in Indiana would not be very favorable as a place of deposit for most marine material.

Provision should also be made for putting deposited documents in fairly uniform packages. In the case of statistical tables such as my own the ordinary typewriter sheets (8 x 11 inches) would probably be most satisfactory. It would then be an easy matter for the institution of deposit to tie them up or put them in clip binders for convenient and economical storage.

If definite plans can be made for some such dispersal they will surely greatly expedite the issuance of papers using large volumes of quantitative and statistical records. Such papers may then get into print and into use while still comparatively fresh. Furthermore the worker in such lines will not have so much reason to be discouraged by long delay in publication, following the monotony (and sometimes dreary drudgery) of making, accumulating and interpreting the records.

W. E. Allen

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ALFRED GOLDSBOROUGH MAYOR

To the Editor of Science: When I saw the name "Alfred Goldsborough Mayor" at the head of Dr. Woodward's most interesting and appreciative notice of his late associate I suspected a typographical error, but when I saw the same name "Mayor" throughout the article and found it the same in "Who's Who" and in the list of members of the National Academy of Sciences, I realized that a change, which had escaped my notice, in the spelling of this well-known name had been made by the son of my old friend, Professor Alfred M. Mayer, the charming and accomplished professor of physics who for so many years was the head of that department at the Stevens Institute of Technology.

One would like to know the reason for this, which may have been due to the not infrequent pronunciation of the original spelling as if it were "Myer," but this seems an insufficient excuse for abandoning a form so long and so well known in the world of science and art.

Besides the distinguished father of the late biologist, his uncle, Frank Blackwell Mayer, was an eminent artist who studied in Paris, exhibited in the French salon, won a prize for his paintings at the Centennial exhibition in Philadelphia and made special studies of Indian types in the west.

His father's uncle, Brantz Mayer, was a distinguished historian and archeologist, the author of numerous volumes and the founder of the Maryland Historical Society.

Alfred M. Mayer also studied in Paris and always exhibited a fondness for and even a prejudice in favor of French men, methods and books, and I had always assumed that the family was of French origin, a hypothesis which received some confirmation in the fact that one "Constant Mayer," a French artist, came to this country about the middle of the

last century and rose to distinction in his profession, though I have no evidence of his being closely related to the Maryland Mayers.

By all of the latter, except the subject of Dr. Woodward's sketch, the name was invariably spelled with an "e" in the last syllable. The future student of heredity is very likely to be misled by this change, which seems unfortunate unless there existed some sufficient reason, not apparent at this moment.

T. C. MENDENHALL

RAVENNA, OHIO

SCIENTIFIC BOOKS

Terrestrial and Celestial Globes, their history and construction including a consideration of their value as aids in the study of geography and astronomy. By EDWARD LUTHER STEVENSON, New Haven, Yale University Press, published for the Hispanic Society of America, 1921, Volume I, xxvi + 218 pp., 95 plates; Volume II, xii + 292 pp., 72 plates.

These magnificent volumes present in a most interesting way the development of globes from earliest times up to the nineteenth century. The first volume treats terrestrial globes in antiquity, celestial in antiquity, globes of the Arabs, globes of the Christian middle ages, those constructed in the period of the great discoveries, and in four further chapters globes of each quarter of the sixteenth century. The second volume discusses globes of the seventeenth and eighteenth centuries in two chapters each, with a final chapter on the technic of globe construction, including materials and methods particularly of making the gores.

A bibliographical list, which makes no pretense of being exhaustive, gives approximately 600 titles; an "Index of Globes and Globe Makers" occupies 25 pages; and finally a "General Index" follows, occupying 16 pages. For use as an ordinary index the inclusion of items of the bibliographical list and names given in the index of globes and globe makers would have been highly desirable. As it is all three indices must be consulted to determine whether given items are mentioned in the work.

The section devoted to Arabic globes and the section relating to globes in antiquity are based upon material of thirty years ago and longer. There is more recent material, and the use of modern works would have improved these chapters. In particular no mention is made of Suter's great work on the mathematicians and astronomers of the Arabs[1] which includes the references of the Fihrist. Suter mentions as writers on the use of the armillary sphere, or on the planisphere or astrolabe, Al-Sufi and Al-Fazari (p. 3) of the eighth century, Al-Nairizi of the tenth (p. 45) and also Al-Biruni, Al-Zarkali of the eleventh, and Ibi- al-Bannah, whose activity extended into the fourteenth century. Al-Zarkali's instruments were famous and one of his works discussing instruments was published in Latin translation by Johann Schoner at Nürnberg in 1534.

With reference to the Greek conception of a globular earth the works of both T. L. Heath[2] and of the late Pierre Duhem[3] contain the latest and best information by the highest authorities on these matters. It may be of interest to note that Theon of Smyrna C. 150 A.D. (ed. J. Dupuis, Paris, 1892, p. 287) states that the Babylonians "explained celestial phenomena" and were able "to predict celestial phenomena to come, the Chaldeans by the aid of arithmetical methods, the Egyptians by graphical methods."

The bibliography could easily have been extended to give more adequate conception of the wide interest in globes, and the large amount of literature bearing directly upon globes in works of the sixteenth to nineteenth centuries.

Probably the most notable omission is that of any reference to one of the earliest works in the English language containing an extensive discussion of both celestial and terrestrial globes. Robert Recorde, an English physician,

[1] Suter: "Die Mathematiker und Astronomen der Araber," *Abhandl. zur Geschichte der Math. Wissenschaften*, Vol. 10, 1900.

[2] T. L. Heath: "Aristarchus of Samos, . . . A History of Greek Astronomy to Aristarchus, etc.," Oxford, 1913; "A History of Greek Mathematics," Oxford, 1921, 2 vols. In Vol. II, pp. 17-18, Heath states that Archimedes wrote a work on *Sphere-making* which is lost.

[3] "Le Système du Monde," 5 vols., Paris, 1913-1917.

wrote in English treatises on Arithmetic, Algebra, Geometry and Astronomy which were the most widely used of sixteenth century English text-books on mathematics. The titles were intended to be attractive: The Grounde of Artes, the Whetstone of Witte, The Pathwaie to Knowledge, and The Castle of Knowledge. The last mentioned is the astronomical work, published in London in 1556, and contains a section on pages 35-60, "The Seconde treatise of the Castle of Knowledge wherein is taughte the makinge of the materiall sphere, as well in sounde or massy forme, as also in ryng forme with hoopes." Recorde discusses the mounting of such spheres as well as the use of them.

An earlier Englishman who deserves passing mention is William Batecombe or Badecumbe who is reputed to have written about 1420 two works evidently on spheres: De Sphæra Solida and De Sphæra Concava fabrica et usu. The former of these works is reported by Bale to have been in the library of Robert Recorde.

Another sixteenth century writer who deserves mention is Fr. Baroccius whose Cosmografia published at Venice in 1585 contains material on globes and a passage (p. 227-228) "vsi sumus globo terrestri, quem Gaspar Vopelius Mathematicus anno 1553 ab ortu Christi construxit." No globe of this date by Vopel is known; while Stevenson, following Fiorini, ascribes an armillary sphere to one Giovanni Maria Baroccius, it might equally well be due to this astronomer.

The bibliographical list is unsatisfactory in several points. The items are not included in the final index; many items relate to works not cited in the text, and the title as given frequently does not indicate why the work should be included; many treatises and discussions of globes widely used and easily accessible in New York are not included.

As an illustration of a title which does not indicate the reason for its inclusion, take the Cosmografia of Peter Smit. The 1720 edition which is available to me here includes in the title the phrase "Als mede het maken van de Hemelsche en Aardsche Globe," but this is left out in the bibliography.

A work on the globe which went through three editions by 1661 is Pierre Bourdin's Traité de l'usage du globe terrestre, included in his Le Cours de Mathématique (Bibl. Chem. Math., 2 vols. 1921). Such a work should be included.

Of English discussions of globes Sotheran's recent catalogue mentions two that are anonymous: The antiquity and excellency of globes, 26 pp., 1652, and Treatise of the Descriptive Use of both Globes, 1718. I have an anonymous treatise in German, Einleitung zur Erkent. und Gebrauch der Erd und Himmels-Kugeln, Nürnberg, 1767, which mentions Lowiz and also a Professor Hasen in Wittenberg as designers of the Homann globes.

In view of the distinguished author's connection with the Hispanic Society the references to Spanish works treating globes are surprisingly limited in number. Among Spanish treatises on the subject which apparently enjoyed wide popularity in the eighteenth century may be mentioned Thomas Vicente Tosca's discussion. This appeared in the eighth volume (out of nine volumes) in the third edition of Tosca's Compendio Mathematico published at Valencia in 1757; it is in the geography, Libro IV, pp. 157-184, under the title, "De la fabrica y uso del Globo Geographico, y de todo genero de Mapas." The writer treats the making both of gores and of moulds.

A similar and contemporary German work which went through numerous editions was Johann Christian Wolff's Elem. Math. Universæ. The edition published in five folio volumes in Verona, 1746-1751, contains De Globi terrestri artificialis constructione et usu, in Vol. IV and De Globo coelesti artific, in Vol. III, with discussion of gores.

No uncertainty need be entertained as to the date when Lalande made his celestial globe (II, p. 182), as in his Astronomie, Paris, 1792, Vol. I, p. 247, Lalande says: "J'ai publié un nouveau globe celeste en 1775." On pages 616-617 of Vol. III Lalande discusses the manufacture of globes. But more interesting is the price list of globes in 1791 which he gives in Vol. I, pp. lx-lxiii. The celestial and terrestrial mounted, etc., of Robert of Vaugandy, the two for 300 livres in size $17\frac{1}{2}$ ponces; the one foot size, corrected by Messier, the two for 80 livres; 10 inch at 15 livres each. The

then more recent globes of Bonne and Lelande were sold in the one foot size at 100 livres the pair; 10 inch at 18 livres; 8 inch at 10 livres; 6 inch at 7 livres. The prices are more than double those quoted by Stevenson (II, 136) from Moxon, a century earlier.

Lalande cites among the enormous globes one at Cambridge and one at Lyon by Picpus de la Guillotiere. Lalande further states that the finest of the large terrestrial globes is that made in 1787 by D. Bergerin. The Cambridge celestial globe was made, according to the *Encyclopedia Britannica* (IX edition, Vol. X, Globes, p. 683) about 1764 by Dr. Roger Long, professor of astronomy and master of Pembroke College. This globe was 18 feet in diameter, lined with tin. No one of these three men is mentioned by Stevenson.

Nowhere does the author touch upon early appearances of globes in America, North or South. One would expect to find the earliest references in Mexico or Peru; certainly in North America globes must have been imported in the eighteenth century and possibly even constructed here. In the geography by John Payne, revised by James Hardie, that appeared in New York in 1798, there is a figure of an artificial sphere and pages xxxi-xxxviii are devoted to the use of the globe; other references could doubtless be found.

These additions have been made to indicate the wide appeal which globes have made in the past as instruments of instruction. Stevenson's work may well stimulate a revival of interest in globes for instruction purposes.

The two volumes constitute an enduring monument of American scholarship. The press work and the plates are up to the highest standards of the finest presses of Europe. It is to be hoped that students of astronomy and geography in American colleges will make the appearance of a second edition of more than 1,000 copies necessary. The author is to be congratulated upon having added new laurels to his crown in a field closely related to cartography wherein the name of Edward Luther Stevenson has so long stood first in America and almost alone.

L. C. Karpinski

University of Michigan

SPECIAL ARTICLES

THE EFFECT OF ABSORBED HYDROGEN ON THE THERMOELECTRIC PROPERTIES OF PALLADIUM

It is well known that palladium will absorb relatively large quantities of hydrogen under the proper conditions. Palladium black absorbs the gas more readily and in larger quantities than the solid metal but the latter will contain several hundred times its own volume. The purpose of the work here described was to determine the effect of the absorbed gas on the thermoelectric properties of the metal.

The palladium used was in the form of a strip $0.01 \times 0.125 \times 10$ cm. It was first annealed in a vacuum at a temperature of 1,000° C., and then used in a thermo couple with a strip of platinum as the other metal. The cold junction was kept at 0° C. and the hot junction could be heated to various temperatures up to 300° C. This strip of platinum was used as a reference metal throughout all of the determinations.

After the thermoelectric power was obtained, the palladium strip was heated to a temperature of about 700° C., in vacuo, and then allowed to cool slowly in an atmosphere of hydrogen. It is well known that palladium will absorb hydrogen under these circumstances. The thermoelectric power obtained with the gas filled metal against platinum was less than with gas free metal, amounting in one case, at O° C., for instance, to 73 per cent. of the gas free value. The palladium was then heated in vacuo to a temperature of about 700° C., to remove the hydrogen, and another determination showed the thermoelectric power to have returned to its gas free value. This process was repeated several times, the gas filled palladium having its thermoelectric power against platinum lowered each time hydrogen was absorbed, and restored again to its original value after the hydrogen had been removed.

A much greater decrease in the thermoelectric power of palladium against platinum as a reference metal was obtained when the palladium was filled with hydrogen by the electrolytic method. The palladium strip was used as the cathode in the electrolysis of water from a very dilute solution of sulphuric acid. The

nascent hydrogen obtained in this way is very active in penetrating the palladium. At 0° C., the thermoelectric power of the palladium, after being exposed to nascent hydrogen, was in one case only 28 per cent. of the value for the gas free metal. The process of filling with hydrogen by the electrolytic method and then removing the gas by heating in vacuo to about 700° C. was repeated several times and each time the thermoelectric power was lowered by about the same amount as a result of the absorption of the gas and restored to the original gas free value upon removal of the hydrogen.

To obtain the largest effects it was necessary to use the palladium soon after it had been exposed to the hydrogen as the gas slowly diffused away from the metal over a period of several days. Also if the region containing the temperature gradient of the gas filled strip were heated during a determination of thermo e m f, the result was a removal of the hydrogen and a restoration to the original gas free value of thermoelectric power. During a determination of thermo e m f the conduction of heat from the hot junction along the palladium strip caused the evolution of some of the gas and for the higher temperatures of the hot junction the thermoelectric power approached that for the gas free metal.

These results show that a monometallic circuit consisting of gas free and gas filled palladium will give rise to a thermo e m f when the junctions are at different temperatures. Since palladium is negative at the cold junction of a palladium-platinum couple, and since the absorption of hydrogen causes a reduction in thermoelectric power, it follows that gas filled palladium is positive to the gas free metal at the cold junction. Data obtained for one case in which the palladium was electrolytically filled give the value of the thermo e m f in such a monometallic circuit as: $E = 0.12\theta - 0.00023\theta^2$, where θ is the temperature of the hot junction, the cold junction being to 0°C. The constants will depend upon how completely the palladium is filled with hydrogen.

According to the electron theory of thermoelectricity the thermoelectric power (e) of a couple is given by the expression: $e = K \log\frac{n_a}{n_b}$, where K is a constant, n_a and n_b are the effective electron densities in the two materials forming the circuit. When n_a is larger than n_b the current flows from material a to material b at the cold junction. The effect of absorbed hydrogen, then, is to increase the effective electron density in palladium.

R. M. HOLMES

DEPARTMENT OF PHYSICS,
CORNELL UNIVERSITY,
JUNE 10, 1922

THE EFFECT OF SPERM BOILED IN OXALATED SEA-WATER IN INITIATING DEVELOPMENT

IN connection with certain experiments (the results of which have not yet been published) that were made in an attempt to analyze the rôle of calcium in the fertilization of the egg of *Nereis*, the following results were obtained: (1) *Nereis* sperm that have been treated with oxalated sea-water are capable of fertilizing normal *Nereis* eggs; (2) *Nereis* eggs treated with oxalated sea-water are capable of fertilization with normal *Nereis* sperm; (3) Eggs of *Nereis* are capable of fertilization in oxalated sea-water. Such eggs form jelly, maturate, cleave and give rise to swimming larvæ in the oxalated sea-water. These larvæ show a varying per cent. of abnormalities; (4) Uninseminated *Nereis* eggs treated with oxalated sea-water (0.5 per cent. and above of sodium or potassium oxalate in sea-water) form swimming larvæ which show differentiation without cleavage; (5) Sperm of *Nereis* boiled in 0.1 per cent. to 0.25 per cent. sodium or potassium oxalate in sea-water are capable of initiating development in the egg of *Nereis*. This last result may be briefly considered.

Uninseminated eggs of *Nereis* obtained by cutting a dry female are exposed to each of three boiled sperm suspensions. These boiled sperm suspensions are made up as follows: one drop of dry sperm in 5 cc of sea-water; one drop of dry sperm in 5 cc of 0.53 M NaCl; and one drop of dry sperm in 5 cc of 0.1 to 0.25 per cent. sodium or potassium oxalate in sea-water. In each case the drop of sperm is carefully placed in the bottom of a test tube and the solution added. The test tube is then quickly brought to the boiling point over a flame and the suspension is kept at the boiling

point for three minutes. To avoid any possibility of living sperm being present, the wall of the tubes are thoroughly flamed. The tubes, together with one containing normal sea-water kept at the boiling point for three minutes, are then set aside to be used after from two to twenty-four hours. For an experiment ten drops of each suspension and ten drops of the boiled sea-water are placed in dishes each containing one drop of dry eggs. Two minutes later to each dish are added ten cc of sea-water. A control, uninseminated eggs in normal sea-water, was always kept. If the control showed jelly formation the experiment was discarded.

Uninseminated eggs of *Nereis* exposed to these boiled sperm suspensions and to boiled sea-water in this way give the following results: boiled sea-water, no development; sperm boiled in sea-water, no effect beyond small per cent. of jelly formation, maturation and differentiation without cleavage; sperm boiled in oxalated sea-water, higher per cent. of differentiation without cleavage. The highest per cent. of swimming larvæ (differentiation without cleavage) ever obtained with the NaCl boiled sperm was about 10 per cent.; the highest with oxalated sperm was 32 per cent. And this proportion usually holds.

The first experiment of this kind was made early in June, 1914. At Dr. F. R. Lillie's suggestion these experiments were repeated directly under his supervision in his laboratory at the Marine Biological Laboratory, Woods Hole, Mass., during each *Nereis* "run" of 1915. It gives me great pleasure to acknowledge my indebtedness to him for many helpful suggestions in this work.

Every possible precaution was taken against contamination; every variation in procedure to be thought of was tried; and throughout one season, whenever *Nereis* eggs were to be had, the experiments were studiously repeated. Despite the precautions and the laborious repetitions, both during 1915 and subsequent seasons, it is impossible to reduce the results to any seeming order. Even after the elimination of certain sources of error the results are inconstant. The sources of error may be mentioned:

1. Failure to use perfectly fresh eggs of high cortical sensitivity. In 1915 I had great difficulty in keeping the worms from shedding their eggs when kept in the laboratory over night. I therefore adopted the plan of keeping the animals in the refrigerator. But this only made matters worse, for the females shed very quickly on removal from the low temperature. Such eggs were of little value. Moreover, if transfer from the cold sea-water to that at room temperature be suddenly made not only are the eggs shed but they are induced to form jelly and maturate. Moreover, eggs from animals that have been kept at low temperature are not best for study of cortical changes. Such eggs are apt to be polyspermic and in other ways give evidence of change in the cortical reaction. I have found that keeping *Cumingia* (dry) in the refrigerator markedly changes the normal cortical reactions. The eggs of both forms kept in this way give good cleavage and swimmers, but they do not give the best cortical reactions. For the work with sperm boiled in oxalated sea-water, then, one must have fresh eggs taken from *dry* females.

2. The oxalated sea-water should not be more than twenty-four hours old when used. It is best not to use stock solutions. Various experiments were made with different molecular solutions of the oxalates in distilled water plus the addition of double sea-water to correct the hypotony. But the distilled water solutions seem to deteriorate. It was found best to add from 0.1 to 0.25 grams of the oxalate to 100 cc of sea-water which was filtered before use. But even with fresh eggs and the optimum oxalated sea-water the results are far from uniform.

Since hypertonic sea-water alone initiates development in the egg of *Nereis*, we might think that boiling the sea-water is alone responsible for the results. But boiled sea-water alone has no effect. Since oxalate in sea-water initiates development, we might argue that it is the oxalate in the sea-water rather than the dead sperm that initiates development. However, oxalate alone to call forth development must be present in greater amount than in the suspension of sperm boiled in oxalated sea-water.

My first thought in making these experiments was that calcium is necessary for fertilization on the assumption that in some way it holds intact a substance loosely bound to the sperm head which makes possible the reaction of the sperm with the egg. Calcium free sea-water, then, would bring about the loss of this substance and thus render fertilization impossible. If, however, fertilization takes place in oxalated sea-water, this assumption is untenable.

On the basis of Robertson's work, which indicates that "fertilizing" substance can not be extracted in presence of calcium, we might conclude that the *Nereis* experiments here cited show that the effect of boiling sperm in oxalated sea-water is to extract a fertilizing substance from the sperm. This I do not believe and for several considerations.

Though hypertonicity is not responsible for the results here reported, nevertheless, boiling must certainly increase the salt content of the oxalated sea-water. Again, any amount of oxalate present above that necessary to remove calcium must increase on boiling. Moreover, in the sea-water itself chemical changes ensue through boiling. And finally, on boiling, the sperm perhaps lose specificity—they act as any foreign colloid which may induce development.

The results here reported might thus be due to the total of these several factors each of which alone is incapable of calling forth development. I conclude, therefore, that the results here reported do not indicate that they are due to a fertilizing substance extracted from the sperm.

E. E. Just

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THE WESTERN SOCIETY OF NATURALISTS

The annual meeting of the Western Society of Naturalists was held in Salt Lake City, Utah, June 22-23, 1922, during the convocation of the Pacific Division, American Association for the Advancement of Science. Presiding officers were Dr. F. B. Sumner, *president*, and Dr. J. F. McClendon, *secretary pro tem.*

The following officers were chosen at the annual election: H. S. Reed, *president;* Chester Stock, *vice-president*, and C. O. Esterly, *secretary.*

The program presented was as follows:

June 22

PHYSIOLOGICAL PAPERS

The occurrence of essential oils in desert plants: Maxwell Adams.

The influence of temperature upon the germination of orange seed: H. S. Fawcett.

Influence of gravity on the development of new growth on horizontal shoots: F. F. Halma.

Mitosis in rhizopods and flagellates: C. A. Kofoid.

Longevity of Artemia in natural and artificial brines: E. G. Martin.

Some quantitative aspects of growth: H. S. Reed.

Dendograph record of the redwood (with lantern slides): D. T. MacDougal.

The occurrence of goitre in relation to the distribution of iodine: J. F. McClendon.

HEREDITY AND EVOLUTION

The two chromosomes of Clarkia: L. L. Burlingame.

Inheritance of flower color in Clarkia: L. L. Burlingame.

The law of geminate species: D. S. Jordan.

Theories as to the mode of evolution: J. P. Lotsy.

The origin and inheritance of specific characters: F. B. Sumner.

Darwinism—an analysis by observation and experiment: W. L. Tower.

June 23

PAPERS READ IN JOINT SESSION WITH THE ECOLOGICAL SOCIETY OF AMERICA

The original grasslands of California: F. E. Clements.

Why not conserve the marine mammals of the Pacific? B. W. Evermann.

Factors limiting the distribution of Teredo navalis in San Francisco Bay: C. A. Kofoid.

Climate of the Inland Empire in relation to silviculture and forest fires: J. A. Larsen.

Food and game fishes of the Snake River, Great Basin: S. B. Locke.

Wild bird life of the rookeries on the islands of Great Salt Lake (with motion pictures): C. G. Plummer.

A bog forest near Victoria: G. B. Rigg.

Chester Stock,
Secretary